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CLAIMS

1. A semiconductor device comprising:

a substrate;

a gate insulating film formed on said substrate, and having a nitrogen-containing metal silicate film or a nitrogen-containing metal aluminate film that contains a metal in a peak concentration of 1 atomic % or more and 30 atomic % or less on the uppermost layer; and

a gate electrode formed on said gate insulating film.

2. A semiconductor device comprising:

a substrate;

a gate insulating film formed on said substrate, and having:

a base interface layer formed on said substrate,

a metal silicate film formed on said base interface layer, and containing a metal, oxygen and silicon, and

a nitrogen-containing metal silicate film that contains a metal, oxygen, silicon, and nitrogen; and

a gate electrode formed on said gate insulating film; wherein

said nitrogen-containing metal silicate film contains said metal in a peak concentration of 1 atomic % or more and 30 atomic % or less.

3. The semiconductor device according to claim 2, wherein said metal silicate film contains said metal in a peak concentration of 5 atomic % or more and 40 atomic % or less.

4. The semiconductor device according to claim 1, wherein said nitrogen-containing metal silicate film contains said nitrogen

in a peak concentration of 10 atomic % or more and 30 atomic % or less.

5. A method for manufacturing a semiconductor device comprising the steps for:

forming a base interface layer on a substrate;

forming a metal silicate film containing a metal in a peak concentration of 1 atomic % or more and 30 atomic % or less on said base interface layer;

forming a nitrogen-containing metal silicate film containing nitrogen in a peak concentration of 10 atomic % or more and 30 atomic % or less on the upper layer of said metal silicate film; and

forming a gate electrode on said nitrogen-containing metal silicate film.

6. The method for manufacturing a semiconductor device according to claim 5, wherein

said step for forming said metal silicate film performs the combination of:

a first step for forming a metal oxide film by supplying a metal-containing material, and then supplying an oxygen-based gas onto said substrate; and

a second step for forming a silicon oxide film by supplying a silicon-containing material, and then supplying an oxygen-based gas onto said substrate; and

said step for forming said metal silicate film performs said combination of steps controlling the number of said first and second steps.

7. The method for manufacturing a semiconductor device according to claim 6, wherein said first step repeatedly performs the steps for:

supplying said metal-containing material onto said substrate;

supplying said oxygen-based gas onto said substrate; and

radiating light onto the surface of said substrate for a time up to several milliseconds.

8. The method for manufacturing a semiconductor device according to claim 6, wherein said second step repeatedly performs the steps for:

supplying said silicon-containing material onto said substrate;

supplying said oxygen-based gas onto said substrate; and

radiating light onto the surface of said substrate for a time up to several milliseconds.

9. A method for manufacturing a semiconductor device comprising the steps for:

forming a base interface layer on a substrate;

forming a metal silicate film containing a metal in a peak concentration of 5 atomic % or more and 40 atomic % or less on said base interface layer;

forming a nitrogen-containing metal silicate film containing a metal in a peak concentration of 1 atomic % or more and 30 atomic % or less and nitrogen in a peak concentration of 10 atomic % or more and 30 atomic % or less on said metal silicate film; and

forming a gate electrode on said nitrogen-containing metal silicate film.

10. The method for manufacturing a semiconductor device according to claim 9, wherein

said step for forming said metal silicate film performs the combination of:

a first step for forming a metal oxide film by supplying a metal-containing material, and then supplying an oxygen-based gas onto said substrate; and

a second step for forming a silicon oxide film by supplying a silicon-containing material, and then supplying an oxygen-based gas onto said substrate; and

said step for forming said metal silicate film performs said combination of steps controlling the number of said first and second steps.

11. The method for manufacturing a semiconductor device according to claim 10, wherein said first step repeatedly performs the steps for:

supplying said metal-containing material onto said substrate;

supplying said oxygen-based gas onto said substrate; and

radiating light onto the surface of said substrate for a time up to several milliseconds.

12. The method for manufacturing a semiconductor device according to claim 10, wherein said second step repeatedly performs the steps for:

supplying said silicon-containing material onto said substrate;

supplying said oxygen-based gas onto said substrate; and

radiating light onto the surface of said substrate for a time up to several milliseconds.

13. The method for manufacturing a semiconductor device according to claim 9, wherein said step for forming said nitrogen-containing metal silicate film comprises the steps for:

forming a base metal silicate film containing a metal in a peak concentration of 1 atomic % or more and 30 atomic % or less; and

introducing nitrogen into said base metal silicate film in a peak concentration of 10 atomic % or more and 30 atomic % or less by nitriding said metal silicate film.

14. The method for manufacturing a semiconductor device according to claim 5, wherein;

said step for forming a base metal silicate film performs the combination of;

a first step for forming a metal oxide film by supplying a metal-containing material, and then supplying an oxygen-based gas onto said substrate; and

a second step for forming a metal oxide film by supplying a silicon-containing material, and then supplying an oxygen-based gas onto said substrate;

and controls the number of said first and second steps to form said metal silicate film.

15. The method for manufacturing a semiconductor device according to claim 14, wherein said first step repeatedly performs the steps for:

supplying said metal-containing material onto said substrate;

supplying said oxygen-based gas onto said substrate; and

radiating light onto the surface of said substrate for a time up to several milliseconds.

16. The method for manufacturing a semiconductor device according to claim 14, wherein said second step repeatedly performs the steps for:

supplying said silicon-containing material onto said substrate;

supplying said oxygen-based gas onto said substrate; and

radiating light onto the surface of said substrate for a time up to several milliseconds.

17. A apparatus for forming a film comprising:

a housing;

a table installed in said housing, for placing a substrate;

a gas supply port for supplying a gas into said housing;

a gas discharge port for discharging the gas in said housing out of said housing; and

a heater for heating the surface of said substrate by radiating light on the surface of said substrate placed on said table for a time up to several milliseconds.

18. The apparatus for forming a thin film according to claim 17 wherein said heater includes a flash lamp.

19. A method for forming a high-dielectric-constant film on a substrate comprising the steps for:

supplying a first material gas that contains at least one element in elements constituting said high-dielectric-constant film into a housing wherein said substrate is placed;

supplying a second material gas that reacts with said first material gas and forms said high-dielectric-constant film into said housing; and

heating the surface of said substrate by radiating light onto the surface of said substrate for a time up to several milliseconds.

20. The method for forming a high-dielectric-constant film according to claim 19, wherein the time for radiating light in said heating step is from 0.8 to 20 miliseconds.